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(54) [Title of the Invention] ZOOM LENS

(57) [Abstract]

[Problem] A problem occurs, in that a sub-diaphragm 26 is integrally zoom-moved with a main diaphragm 24, and the flare of an upper beam luminous flux 28 cannot be cut.

[Solving Means] In a zoom lens comprising the main diaphragm 24 capable of performing diaphragming up to a small aperture to change the FNO and the sub-diaphragm 26 which is located behind the main diaphragm to change the diameter of the open aperture by the zooming operation, a space between the main diaphragm and the sub-diaphragm is different at each focal distance.

[Claims]

[Claim 1] A zoom lens comprising a main diaphragm capable of performing diaphragming up to a small aperture to change the FNO and a sub-diaphragm which is located behind the main diaphragm to change the diameter of the open aperture by the zooming operation, wherein a space between the main diaphragm and the sub-diaphragm is different at each focal distance.

[Claim 2] The zoom lens according to Claim 1, wherein the sub-diaphragm is arranged at a position where an open FNO luminous flux is across an upper beam luminous flux diagonal thereto at each focal distance, and a space between the main diaphragm and the sub-diaphragm is determined.

[Claim 3] The zoom lens according to Claim 1 or Claim 2, wherein the sub-diaphragm is arranged at a position where an open FNO luminous flux is across an upper beam luminous flux diagonal thereto, and the flare at an intermediate portion of a screen is cut.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] The present invention relates to a zoom lens such as a wide angle zoom lens comprising a main diaphragm capable of performing diaphragming up to a small aperture to change the FNO, and a sub-diaphragm which is located behind the main diaphragm to

change the diameter of the open aperture by the zooming operation.

[0002]

[Description of the Related Art] In a known zoom lens, a motor-driven diaphragm device having a diaphragm diameter correction mechanism to correct the diameter of an open aperture in an interlocking manner with the zooming operation is increased in size, a compact lens barrel cannot be achieved, and from this reason, and the known zoom lens has two diaphragm devices of a motor-driven diaphragm device capable of performing diaphragming to a small aperture to change the FNO (hereinafter, referred to as a main diaphragm), and a sub-diaphragm in which the open diameter of the open aperture is changed in an interlocking manner with the zooming operation (hereinafter, referred to as an open FNO).

[0003] Fig. 3 is a longitudinal sectional view to show the entire structure of the zoom lens in the wide condition. In Fig. 3, reference numeral 1 denotes a guide barrel, and reference numeral 2 denotes a cam barrel which is rotatably fitted to an inside diameter part of the guide barrel 1. A first moving frame 3 for a first lens group and a second moving frame 4 for second and fourth lens groups are fitted to the inside diameter part slidably in the direction of the optical axis. A cam follower 3a which is implanted in the

first moving frame 3 by screws or the like and a cam follower 4a which is implanted in a second moving frame 4 by screws or the like are fitted in cam grooves 2a and 2b formed in the cam barrel 2, respectively, and tip parts thereof are fitted in straight guide grooves 1a and 1b formed in the guide barrel 1, respectively.

[0004] A third moving frame 5 for a third lens group is fitted to the inside diameter part of the second moving frame 4 slidably in the direction of the optical axis, a cam follower 5a implanted in the third moving frame 5 by screws or the like is fitted in a straight guide groove 4b formed in the second moving frame 4, and a tip thereof is fitted in a cam grooves 2c formed in the cam barrel 2.

[0005] Reference numeral 6 denotes a holding frame to hold a part of a lens G2 of the first lens group, and a cam follower 6a implanted in the holding frame 6 by screws or the like is fitted in a cam groove 6b of the first moving frame 3 by screws or the like. A focus key 8 to directly convey the turn of a known ultrasonic motor 7 is fitted in a focus adjustment block 9 is mounted on the holding frame 6 by screws or the like.

[0006] A holding ring 10 to hold a part of the lens G1 of the first lens group is screwed to a tip of the first moving frame 3. A hood mounting ring 11 coupled with the guide barrel 1 by a screw 23 is provided on an outer

circumferential part of the holding ring 10. In addition, a manual ring 12 is turnably fitted in the outer circumferential part of the guide barrel 1, and a manual rubber 13 is wound around a part of its outer circumferential surface.

[0007] In addition, the cam barrel 2 is connected to a zoom ring 16 by a zoom key 14 fixed to the cam barrel 2 by screws and a zoom roller 15 mounted on a tip of the zoom key by screws or the like. Further, a zoom rubber 17 is wound around a part of an outer face of the zoom ring 16, and the zoom rubber 17 is also used for a zoom play removing piece 18. A zoom brush 19 for a zoom encoder is fixed to the zoom key 14.

[0008] A fixed cylinder 21 to be coupled with a mount 20 is coupled with a rear portion of the guide barrel 1 by screws or the like, and a mounted substrate 22 is arranged between the mount 20 and the fixed cylinder. Further, the zoom ring 16 is rotatably fitted in an outside diameter part of the fixed cylinder 21, and thrust-regulated to the zoom key 14 by the zoom roller 15. The manual ring 12 is rotatably fitted in the guide barrel 1, and thrust-regulated by and end 7b of a communication ring 7a of the ultrasonic motor 7 and an end 21a of the fixed cylinder 21.

[0009] A motor-driven main diaphragm device 24 capable of performing diaphragming to a small aperture is mounted on

the third moving frame 5 by a screw 25, and the sub-diaphragm 26 to determine the open FNO is mounted on a rear portion thereof. The sub-diaphragm 26 comprises a holding plate 26a, a swage block 26b and a diaphragm blade 26c. A shaft 26d is integrated with the holding plate 26a, and pivotably supported by a hole 5b of the third moving frame 5 to regulate the rotation of the holding plate 26a, and mounted on the third moving frame 5 by a patching pawl (not shown) of the holding plate 26a. The swage block 26b is rotatably bayonet-coupled with the holding plate 26a, and by rotating the swage block 26b, a diaphragm blade 26c is opened/closed to determine the open FNO. The second moving frame 4 has a rotary cam groove 4c of the swage block 26b corresponding to a differential cam between the second group and the third group, and the cam follower 26e is connected to the swage block 26b to determine the opening/closing quantity of the diaphragm blade 26c in each zoom area (each focal distance).

[0010] Next, the operation will be described below. When the holding frame 6 is rotated via the focus key 8 and a focus adjustment block 79 by turning the known ultrasonic motor 7 or the manual ring 12, the focusing is performed longitudinally in the direction of the optical axis along the cam grooves 6b of the first moving frame 3. Further, when the zoom ring 16 is turned, the cam barrel 2 is rotated

via the zoom roller 15 and the zoom key 14. Thus, the first moving frame 3 and the holding frame 6 are guided to the cam grooves 2a of the cam barrel 2 and the straight guide grooves 1a of the guide barrel 1, similarly, the second moving frame 4 is guided to the cam grooves 2b and the straight guide grooves 1b, and similarly the third moving frame 5 is guided to the cam grooves 2c and the straight guide grooves 4b to perform the zooming by the movement along the direction of the optical axis.

[0011] In this situation, in the sub-diaphragm 26, accompanied with the movement of the second group and the third group in the direction of the optical axis, the swage block 26b is rotated by the cam groove 4c of the second moving frame 4 to open/close the diaphragm blade 26c.

[0012] Fig. 4 is an enlarged view of a major part in which a diagonal luminous flux is added to the sub-diaphragm part in a same wide state as that in Fig. 3. In Fig. 4, a double-dot-chain line 27 indicates a wide open FNO luminous flux, a solid line 28 indicates an upper beam luminous flux at the image height of 10 mm, and broken lines 40a and 40b indicate an upper beam luminous flux and a lower beam luminous flux in a diagonal arrangement (at the image height of 21.635 mm), respectively.

[0013] Since the sub-diaphragm 26 is mounted at the thrust position A in Fig. 4 in the relationship of the mechanical

space of Tele, and, the flare of the upper beam luminous flux 28 at the image height of 10 mm reaches the top of a film.

[0014] In the zoom lens, even in an open state, the motor-driven diaphragm device performs the diaphragming to the vicinity of the open FNO luminous flux at each focal distance, the incident light quantity on an intermediate portion of the screen can be limited, and reduction of the peripheral light quantity at the intermediate portion and the peripheral portion of the screen is made less conspicuous with the flare-cut effect.

[0015]

[Problems to be Solved by the Invention] In the known zoom lens, the motor-driven diaphragm device performs the diaphragming to a vicinity of the open FNO luminous flux to perform the flare-cut of the lower beam luminous flux incident on the intermediate portion of the screen. However, the sub-diaphragm is integrally zoom-moved with the motor-driven diaphragm device (the main diaphragm), raising a problem in that the flare-cut of the upper beam luminous flux is not effectively performed.

[0016] The present invention is achieved to solve the above-described conventional problems, and an object of the present invention is to obtain a zoom lens capable of effectively performing the flare-cut of the incident upper

beam luminous flux.

[0017]

[Means for Solving the Problems] A zoom lens of the invention according to Claim 1 comprises a main diaphragm capable of performing diaphragming up to a small aperture to change the FNO and a sub-diaphragm which is located behind the main diaphragm to change the diameter of the open aperture by the zooming operation, and a space between the main diaphragm and the sub-diaphragm is different at each focal distance.

[0018] In a zoom lens of the invention according to Claim 2, the sub-diaphragm is arranged at a position where an open FNO luminous flux is across an upper beam luminous flux diagonal thereto at each focal distance, and a space between the main diaphragm and the sub-diaphragm is determined thereby.

[0019] In a zoom lens of the invention according to Claim 3, the sub-diaphragm is arranged at a position where an open FNO luminous flux is across an upper beam luminous flux diagonal thereto, and the flare at an intermediate portion of a screen is cut.

[0020]

[Embodiments] An embodiment of the present invention will be described below.

Embodiment 1. Fig. 1 is a longitudinal sectional view to

show the entire structure of a zoom lens in a wide state, The components of the zoom lens shown in Fig. 3 according to the present embodiment which are identical to or correspond to those in the known zoom lens are represented by the same reference numerals, and a detailed description thereof is omitted. In Fig. 1, reference numeral 50 denotes a fourth moving frame, and a cam follower 50a implanted in the fourth moving frame 50 by screws or the like is fitted in the straight guide groove 4d formed in the second moving frame 4 and the cam groove 2d formed in the cam barrel 2. The sub-diaphragm 26 is mounted on the fourth moving frame 50 by a patching pawl (not shown). When the zoom ring 16 is turned, it is guided by the cam groove 2d of the cam barrel 2 and the straight guide groove 4d of the second moving frame 4, and the zoom lens is arranged at the position in which the open FNO luminous flux is across the upper beam luminous flux diagonal thereto at each focal distance, and the flare of the intermediate portion of the screen can be effectively cut.

[0021] Fig. 2 is an enlarged view of a major part of the sub-diaphragm part. A one-dot-chain line 28c indicates the upper beam luminous flux at the conventional image height of 10 mm, and in the present embodiment, the flare can be cut as shown in the figure by arranging the sub-diaphragm 26 at the position in which the open FNO luminous flux is across

the upper beam luminous flux diagonal thereto at each focal distance.

[0022]

[Advantages] As described above, according to the present invention, in a zoom lens comprising a main diaphragm capable of performing diaphragming up to a small aperture to change the FNO and a sub-diaphragm which is located behind the main diaphragm to change the diameter of the open aperture by the zooming operation, a space between the main diaphragm and the sub-diaphragm is different at each focal distance, the sub-diaphragm is arranged at a position where an open FNO luminous flux is across an upper beam luminous flux diagonal thereto at each focal distance, and the flare entering an intermediate portion of a screen is cut.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a longitudinal sectional view to show the entire structure of a zoom lens in a wide state according to an embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is an enlarged view of a major part of a sub-diaphragm part shown in Fig. 1.

[Fig. 3] Fig. 3 is a longitudinal sectional view to show the entire structure of a known zoom lens in a wide state.

[Fig. 4] Fig. 4 is an enlarged view of a major part of a sub-diaphragm part shown in Fig. 3.

[Reference Numerals]

24 main diaphragm

26 sub-diaphragm

27 open FNO luminous flux

28 upper beam luminous flux

FIG. 1

(1) FIRST GROUP

(2) SECOND GROUP

(3) THIRD GROUP

(4) FOURTH GROUP